

WHAT IS CLAIMED IS:

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1. An optical device comprising:

an optical element having a container and first  
and second liquids contained sealingly in said  
5 container, said first and second liquids being  
substantially equal in refractive index, said first and  
second liquids existing without mixing with each other,  
said first and second liquids differing from each other  
in transmittance, said first and second liquids making  
10 the boundary between said first and second liquids  
having a predetermined shape; and

an electrode formed in such a place as to avoid  
interference with passage of a bundle of rays incident  
upon said optical element.

2. An optical device comprising:

an optical element having a container and first  
and second liquids contained sealingly in said  
container, said first and second liquids being  
20 substantially equal in refractive index, said first and  
second liquids existing without mixing with each other,  
said first and second liquids differing from each other  
in transmittance, said first and second liquids making  
the boundary between said first and second liquids  
25 having a predetermined shape;

an electrode formed in such a place as to avoid  
interference with passage of a bundle of rays incident

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upon said optical element; and

a voltage application circuit for applying a voltage to said electrode,

wherein the shape of the boundary between said two liquids is changed by application of a voltage through said electrode to change the quantity of transmitted light in the bundle of rays passing through said optical element.

10           3. An optical device according to Claim 1,  
wherein said electrode comprises a first electrode and  
a second electrode insulated from said first liquid,  
said first electrode being formed so as to be in  
communication with said first liquid through a side  
15           portion of said container, said second electrode being  
formed in a side portion of said container.

20           4. An optical device according to Claim 1,  
wherein said electrode comprises a ring-shaped  
electrode formed so as to surround said second liquid.

25           5. An optical device according to Claim 2,  
wherein said electrode comprises a first electrode and  
a second electrode insulated from said first liquid,  
said first electrode being formed so as to be in  
communication with said first liquid through a side  
portion of said container, said second electrode being

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formed in a side portion of said container.

6. An optical device according to Claim 2,  
wherein said electrode comprises a ring-shaped  
5 electrode formed so as to surround said second liquid.

7. An optical device according to Claim 1,  
wherein a side surface of said container has a plane  
inclined at a predetermined angle from the optical axis  
10 of the bundle of rays incident upon said optical  
element, and said first and second liquids are  
contained in said container in such a state that the  
boundary between said first and second liquids has a  
substantially flat shape.

8. An optical device according to Claim 7,  
wherein the thickness of said first liquid along the  
optical axis in a non-energized state is within the  
range of 0.1 to 0.5 mm.

9. An optical device according to Claim 7,  
wherein said electrode is provided along the side  
surface of said container inclined at the predetermined  
angle.

10. An optical device according to Claim 9,  
wherein said electrode comprises a ring-shaped

electrode formed so as to surround said second liquid.

11. An optical device according to Claim 1,  
wherein the optical path length of said first liquid  
5 along an optical axis and the optical path length of  
said second liquid along the optical axis change  
according to a voltage applied to said electrode.

12. An optical device according to Claim 1,  
10 wherein the optical transmittance of said first liquid  
per unit optical path length is lower than the optical  
transmittance of said second liquid per unit optical  
path length, and the optical path length of said first  
liquid along the optical axis increases in accordance  
15 with the distance from the optical axis.

13. An optical device according to Claim 1,  
wherein the optical transmittance of said first liquid  
per unit optical path length is lower than the optical  
20 transmittance of said second liquid per unit optical  
path length, and the optical path length of said first  
liquid along the optical axis changes between zero and  
a finite length according to a voltage applied to said  
electrode.

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14. An optical device according to Claim 1,  
wherein the optical transmittance of said second liquid

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per unit optical path length is lower than the optical transmittance of said first liquid per unit optical path length, and the optical path length of said second liquid along the optical axis decreases in accordance  
5 with the distance from the optical axis.

15. An optical device according to Claim 1, wherein an optical surface on one side corresponding to one of said liquids having a lower optical  
10 transmittance is formed as a curved surface.

16. An optical system in which an image is formed on an image formation plane through a lens element, said optical system comprising at least one of a  
15 diaphragm and a shutter incorporated in said lens element.

17. An optical system according to Claim 16, wherein said at least one of the diaphragm and the shutter is formed by an optical element having a  
20 container and first and second liquids contained sealingly in said container, said first and second liquids being substantially equal in refractive index, said first and second liquids existing without mixing  
25 with each other, said first and second liquids differing from each other in transmittance, said first and second liquids making the boundary between said

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first and second liquids having a predetermined shape, wherein an electrode is formed in said optical element in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element.

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18. A photo-taking device comprising:

an imaging optical system for forming a subject image;

10 an optical element for changing the quantity of transmitted light in a bundle of rays passing through said imaging optical system;

image pick-up means for recording the subject image;

15 said optical element having a container and first and second liquids contained sealingly in said container, said first and second liquids being substantially equal in refractive index, said first and second liquids existing without mixing with each other, said first and second liquids differing from each other  
20 in transmittance, said first and second liquids making the boundary between said first and second liquids having a predetermined shape;

25 an electrode formed in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element; and

a voltage application circuit for applying a voltage to said electrode,

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wherein the shape of the boundary between said two liquids is changed by application of a voltage through said electrode to change the quantity of transmitted light in the bundle of rays passing through said optical element.

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19. An optical device comprising:  
an optical element having a container having a side surface inclined at a predetermined angle from an optical axis, and first and second liquids contained sealingly in said container, said first and second liquids differing substantially from each other in transmittance, said first and second liquids existing without mixing with each other, said first and second liquids making the boundary between said first and second liquids having a rounded shape; and  
an electrode formed in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element.

20. An optical device comprising:  
an optical element having a container having a side surface inclined at a predetermined angle from an optical axis, and first and second liquids contained sealingly in said container, said first and second liquids differing substantially from each other in transmittance, said first and second liquids existing

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without mixing with each other, said first and second liquids making the boundary between said first and second liquids having a rounded shape;

an electrode formed in such a place as to avoid  
5 interference with passage of a bundle of rays incident upon said optical element; and

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an application circuit for applying a voltage to said electrode,

wherein the shape of the boundary is changed by  
10 application of a voltage to change the refractive power with respect to light passing through said optical element.

21. An optical device according to Claim 19,  
15 wherein said electrode comprises a first electrode and a second electrode insulated from said first liquid, said first electrode being formed so as to be in communication with said first liquid through a side portion of said container, said second electrode being  
20 formed in a side portion of said container.

22. An optical device according to Claim 20,  
wherein said electrode comprises a first electrode and a second electrode insulated from said first liquid,  
25 said first electrode being formed so as to be in communication with said first liquid through a side portion of said container, said second electrode being

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formed in a side portion of said container.

23. An optical device according to Claim 21,  
wherein said electrode comprises a ring-shaped  
5 electrode formed so as to surround said second liquid.

24. An optical device according to Claim 21,  
wherein said second electrode is provided along the  
side surface inclined at the predetermined angle.  
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25. An optical device according to Claim 19,  
wherein the optical path length of said first liquid  
along the optical axis and the optical path length of  
said second liquid along the optical axis change  
15 according to a voltage applied to said electrode.

26. An optical device according to Claim 19,  
wherein the refractive index of said first liquid is  
smaller than the refractive index of said second  
20 liquid, and the optical path length of said first  
liquid along the optical axis increases in accordance  
with the distance from the optical axis.

27. An optical device according to Claim 19,  
25 wherein the refractive index of said first liquid is  
smaller than the refractive index of said second  
liquid, and the optical path length of said first

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liquid along the optical axis changes within the range of finite lengths according to a voltage applied to said electrode.

5           28. An optical device according to Claim 19, wherein an optical surface of said container containing said liquids is formed as a curved surface.

10           29. An optical system in which a predetermined image is formed or light of the image is converged by a lens element, said optical system comprising:

a variable-power element incorporated in the lens element.

15           30. An optical system according to Claim 29, wherein said variable-power element has a container having a side surface inclined at a predetermined angle from an optical axis, and first and second liquids contained sealingly in said container, said first and  
20           second liquids differing substantially from each other in refractive index, said first and second liquids existing without mixing with each other, said first and second liquids making the boundary between said first and second liquids having a rounded shape, and

25           wherein an electrode is formed said variable-power element in such a place as to avoid interference with passage of a bundle of rays incident upon said

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variable-power element.

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31. An optical system in which a predetermined image is formed or light of the image is converged by a lens element, said optical system comprising:

an optical element constituting a portion of said optical system, said optical element including a container having a side surface inclined at a predetermined angle from an optical axis, and first and second liquids contained sealingly in said container, said first and second liquids differing substantially from each other in refractive index, said first and second liquids existing without mixing with each other, said first and second liquids making the boundary between said first and second liquids having a rounded shape; and

an electrode formed in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element.

32. A photo-taking device comprising:

an imaging optical system for forming a subject image:

a variable-power optical element incorporated in said imaging optical system, said variable-power optical element including a container having a side surface inclined at a predetermined angle from an

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optical axis, and first and second liquids contained  
sealingly in said container, said first and second  
liquids differing substantially from each other in  
refractive index, said first and second liquids  
existing without mixing with each other, said first and  
second liquids making the boundary between said first  
and second liquids having a rounded shape;

an electrode formed in such a place as to avoid  
interference with passage of a bundle of rays incident  
upon said optical element; and

image pick-up means for recording the subject  
image.

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